HELEN KELLER INTERNATIONAL

FORTIFICATION OF WHEAT WITH VITAMIN A IN BANGLADESH: A DEMONSTRATION PROJECT

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ABSTRACT

This project will reduce child morbidity, mortality and blindness related to vitamin A deficiency by increasing the dietary intake of vitamin A through fortification of wheat provided to participants in public food distribution programs. The specific purpose is to demonstrate the feasibility and nutritional impact of a pilot project for the vitamin A fortification of wheat.

Vitamin A deficiency is a major problem in Bangladesh, causing almost one million children under six years old to suffer from xerophthalmia (ocular signs of deficiency) and 30,000 to be blinded each year. Helen Keller International (HKI) has been assisting the Bangladesh national semi-annual vitamin A capsule distribution program, while simultaneously seeking other ways to alleviate this problem and to reach the poorest of the poor on a sustained basis. The HKI/IPHN Bangladesh Nutritional Blindness Study 1982-1983 identified wheat fortification as a possible way to eliminate blinding malnutrition.

HKI has reviewed options for additional vitamin A intervention programs and has concluded that fortification of wheat distributed by the Government of Bangladesh (GOB) in Vulnerable Group Feeding programs (VGF) and Food for Work programs (FFW) can significantly reduce vitamin A deficiency. Both of these well established, effective food distribution programs are targeted to the poorest, most needy segments of the population, and both can, with relatively minor modification, deliver beneficial amounts of vitamin A to the GOB's primary target groups.

The US Department of Agriculture, Office of International Cooperation and Development (USDA/OICD), Food Technology Branch, assisted HKI in its study of food fortification options. After wheat had been identified as a prime prospect, USDA/OICD further assisted HKI in analyzing the technical and logistical systems for wheat fortification and distribution. Three feasibility studies were undertaken under a USDA/OICD cooperative agreement with HKI including a consumption study of Food for Work (FFW) and Vulnerable Group Feeding (VGF) program participants, an engineering and logistic feasibility study, and an analysis of secondary data. A summary report was prepared by the HKI technical advisor. The USDA/OICD Food Technology Branch and Johns Hopkins University, International Center for Epidemiologic and Preventive Opthalmology assisted HKI in reviewing the studies and reports and in collecting additional information to design an effective vitamin A wheat fortification project.

HKI proposes to carry out a limited wheat fortification demonstration project in which wheat is fortified in one silo and the fortified wheat is distributed to VGF and FFW beneficiaries in an area where there is a high prevalence of xerophthalmia. The wheat will be fortified at the Chittagong silo at an annual rate of 30,000 tons and distributed to VGF and FFW program recipients in the Dhaka Division. These demonstration project recipients will represent approximately 5% of the total Bangladesh VGF and FFW recipients. It will affect approximately 96,000 VGF and 1,050,000 FFW beneficiaries, including an estimated 170,000 children less than 6 years and 60,000 pregnant and lactating women.

The project is expected to require 30 to 36 months for completion. Startup time will be approximately one year to procure fortification equipment and vitamin A fortificant, develop procedures and manuals, and train operational and monitoring staff. The production, distribution, and nutritional impact will be closely monitored over a period of at least 18 to 24 months. Upon completion of the project, it will be evaluated, and, if the results demonstrate success, plans will be developed to expand wheat fortification as to all Bangladesh VGF and FFW recipients.

A. BANGLADESH - DESCRIPTION AND DEMOGRAPHICS

Bangladesh became a sovereign independent state on December 16, 1971 following a devastating war of liberation. The area constituting the country had Muslim rulers for five and a half centuries, from 1201 before passing into British hands after the defeat of the last sovereign ruler, Nawab Sirajuddowla, at the Battle of Plassey in 1757. The British ruled over India for nearly 190 years during which the country, now known as Bangladesh, was a part of the British Indian provides of Bengal and Assam. After the termination of British rule in 1947, it constituted the eastern wing of Pakistan for about 24 years, until independence in 1971.

Bangladesh lies in the northeastern part of South Asia. The country is bounded by India on the west and north, by India and Burma on the east, and by the Bay of Bengal on the south. The area of the country is 55,598 square miles.

Bangladesh is a hot, humid monsoon country for seven months with an annual rainfall exceeding 200 inches in some areas and a cool pleasantly green country for five months of the year. It is a flat, alluvial delta laced by myriad rivers, tributaries of the mighty Himalayan drainage system. Through the borders with India enter the Ganges and Bhramaputra, joining the Jamuna and Meghna rivers. On their way to the Bay of Bengal, millions of tons of fertilizing silt are deposited. Bangladesh has always been subject to frequent floods and cyclones including tidal waves. In some areas, particularly in the coastal belt, the wind speed rises up to 100 miles or more per hour. Tidal waves caused by cyclones play havoc in the coastal belt resulting in extensive deaths and loss of property in the affected areas.

Bangladesh is governed by a unitary presidential form of government. The country is divided into four administrative divisions, under Divisional Commissioners. Each division is sub-divided into 16 districts headed by a Deputy Commissioner. Each district consists of several Upazillas which were formerly known as Thanas (Police Stations). There are 495 Upazillas which are the focal point of public administration and are headed by an elected Upazilla chairman. Local Government in urban and rural areas is entrusted to elected bodies called Pourashavas in the urban areas and Union Parishads (formerly Union Councils) in the rural areas.

Bangladesh is today the eight most populous nation in the world. This fertile land bears one of the world's highest population densities, highest unemployment rates (30 percent of the labor force), lowest per capita health expenditure (less than seven US cents per person), and one of the highest infant mortality rates (136 per thousand). Over 48 percent of the population are 15 years of age or under, and the population is increasing at an annual rate of 2.6 percent. The current population is expected to double in 25 years.

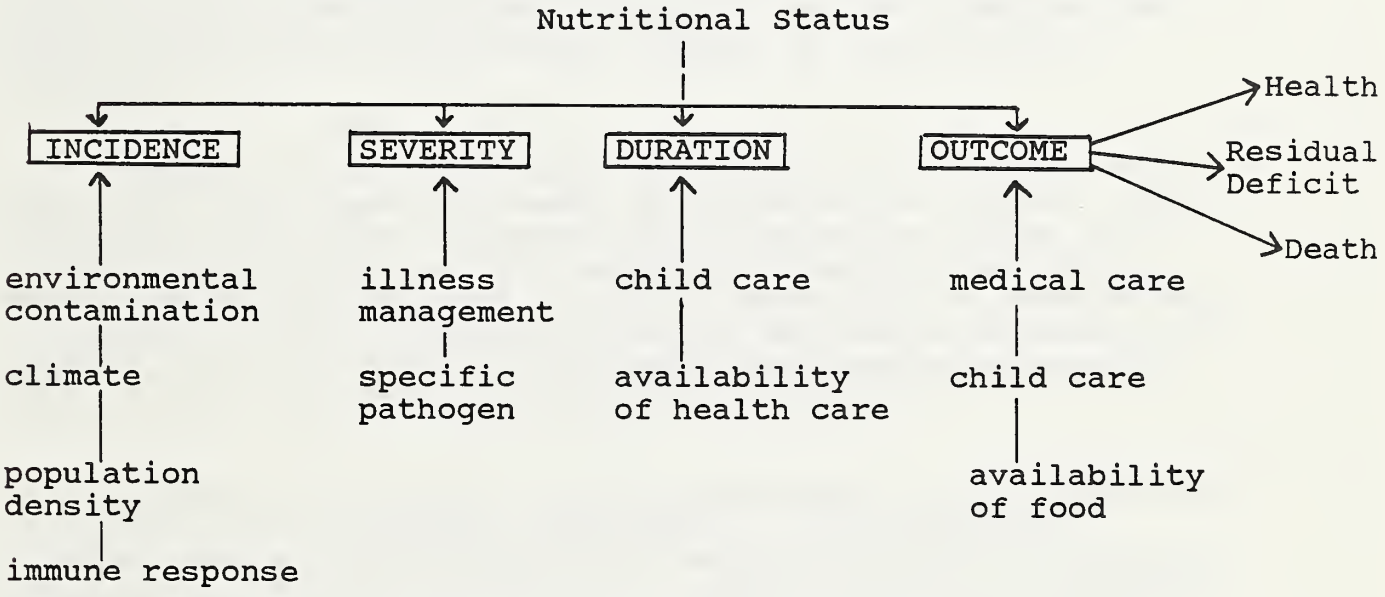
The population of the country is estimated to be about 105 million. Fifteen percent of the population is urban. Assuming a medium variant of declining fertility and mortality, the country is expected to reach a population of 140 million by 2000 A.D. The density of population was 1762 per sq. miles in 1984. There are 15.1 million households in the country distributed over 70,000 mouzas or revenue villages.

Average life expectancy at birth is 48 years. Annual per capita income for 85% of the population is less than $125. U.S. The literacy rate of the country in 1981 was 23.8 percent for people 5 years and over. The percentage of Muslim population is 86.6 while that of Hindu, Buddhist and Christian is 12.1, 0.6 and 0.3 respectively. About 30% of the labor force is unemployed. Very few women work outside the home, and those that do are in urban areas. The average Bangladeshi woman gives birth to six children with an average of four surviving.

B. FACTORS INFLUENCING CHILD HEALTH

The major determinants of infant and child health in Bangladesh are malnutrition and infectious disease and the interaction between them. Of particular importance are protein-energy malnutrition, diarrhea, respiratory illness and measles. Vitamin A deficiency is a major contributor to ill health and the presence of active corneal lesions caused by lack of vitamin A is 10 times higher than the level at which it is considered by WHO to be a public health problem. Anaemia, intestinal parasites and iodine deficiency are also contributing causes to the widespread pattern of child morbidity and mortality.

Tomkins (1) recently suggested a frame-work of factors affecting the incidence, severity, duration and outcome of childhood infectious disease, in relation to nutritional status.



(Simplified version, Tomkins 1986)

Using this simplified version, it can be shown that all the preconditions leading to ill-health are acting on the majority of the children of Bangladesh. They are a population at high-risk, with the risk increasing with the level of poverty.

Vitamin A deficiency is one of the more preventable factors in the observed pattern of child ill-health. It can be mitigated at the levels of the environment, the family, during child care and health care and by increased availability of vitamin A through such means as supplementation and fortification.

A Ministry of Health Diarrhoeal Morbidity and Mortality Survey (2) in rural Bangladesh showed an infant mortality rate (IMR) of 136.3 per 1000 live births; made up of diarrhoea, 12.0; dysentery, 6.0; respiratory infection, 24.0; tetanus, 57.1; measles, 2.0 and other causes, 35.1. The 1986 UNICEF report (3) gives a figure of 130/1000, down from 160 in 1960. The MOH report also gave as the child mortality rate for 0-5 year olds, a high 46.1/1000.

These figures do not reveal however, the interaction of measles, for example, with blinding malnutrition or the important influence of widespread hypovitaminosis A on morbidity and mortality. Several recent studies have shown that vitamin A deficient children have twice as much diarrhea and three times as much respiratory disease as non-deficient children.

Diarrhea plays a role both as an important direct cause of death (the most important cause in children 1-4 years), and as a precipitating cause of kwashiorkor-type malnutrition and corneal xerophthalmia (ocular signs of vitamin A deficiency). Even mild xerophthalmia is linked in Bangladesh to greater risk of diarrhea. Oral rehydration therapy has had an encouraging adoption in rural areas in Bangladesh and community research into the most appropriate formulation continues.

Cultural and economic factors contribute to the high rate of malnutrition throughout Bangladesh. The effects of malnutrition are particularly felt both by the mothers during pregnancy and children through the weaning period. Inadequate caloric and protein intake, along with widespread maternal anaemia, characterizes most pregnancies and leads to a high prevalence of low birthweight babies. To varying extents, mothers observe a complex set of post-partum and lactation food taboos that restrict the nutritional quality of their diet.

While breastfeeding is almost universally practiced, colostrum is generally withheld from infants. In rural Bangladesh, children are breastfed on demand for an average of two years. Introduction of solid foods, however, is delayed until the second year.

The 1982-83 HKI/IPHN Bangladesh National Nutritional Blindness Study (BNBS) (4) found that, of weaning age children (2-3 years), 25% had never been given dark green leafy vegetables (rich in vitamin A precursors) and two-thirds had not eaten them in the past week. Only rice, milk and wheat products were given to more than 20% of the children at least once a day. The period between the ages of 12 and 36 months is one of serious caloric and nutritional deprivation.

The BNBS sampled 22,000 children nationally (the largest nutrition-related survey ever conducted in Bangladesh) to determine their nutritional, dietary, and health status (4). It revealed widespread loss of sight and eye disease related to malnutrition, especially in the northwest, central and southeastern regions of the country. More than 3% of preschool-age children nationwide were night-blind.

The study further found that children from poorer and landless families were significantly more at risk of xerophthalmia. Periodic vitamin A dosing was recommended as a necessary short-term strategy. Fortification with vitamin A of foods commonly given to young children was recommended as a possible long-term strategy and wheat was identified as the most suitable food for fortification.

C. EXISTING HEALTH RESOURCES

The Bangladesh Program for the Prevention of Blindness (BPPB) is the major public health initiative to combat nutritional blindness (xerophthalmia). HKI has continuously provided assistance to this program since 1978 and has had a resident advisor in Bangladesh throughout this period. Operated by the Institute of Public Health Nutrition (IPHN) of the Ministry of Health and Family Planning, BPPB coordinates the semi-annual distribution of capsules (VAC) containing 200,000 international units (IU) of vitamin A to target children in rural households. This is referred to as the VAC distribution program. The program operates through a network of 27,000 field workers, all of whom also have service delivery responsibilities in other primary public health programs.

The 1982-1983 HKI Bangladesh Nutritional Blindness Study estimated the VAC program coverage at 45% nationally and indicated the need for additional training of these workers in vitamin A. Specific target areas for training included awareness of causes of nutritional blindness, potential for prevention and treatment, and disease recognition. BPPB therefore implemented a national training program to upgrade the knowledge and skills of these workers. UNICEF has contributed funding for the training program and also is responsible for production of some of the materials. The government requested that HKI develop the training plan, curriculum, teaching guide, and materials. These have been completed and translated into Bengali. The training will be accomplished through multiple tiers, beginning with four core teams of trainers. These teams will train upazilla level trainers who will train the field level workers. It is anticipated that the training of all workers will be completed within 10-12 months. HKI is participating in training the core teams and higher level health and family planning personnel. Also, through the full-time professional staff officer it provides at IPHN, HKI will assist in monitoring and supervising the training program and in computerizing the distribution of the vitamin A capsules. These activities are funded under Child Survival I.

The other public organization with significant responsibility in nutrition is the National Nutrition Council (NNC). This is an inter-ministerial body including representatives from the Ministries of Agriculture and Health and Family Planning. Other organizations, such as UNICEF and local PVOs including HKI, serve as observers. The NNC establishes national nutrition policy and is responsible for inter-organizational coordination in the nutrition field.

Local PVOs also play an important and complementary role with regard to the nutritional blindness prevention initiative in Bangladesh, and HKI is providing technical support to these groups as well. Its primary activities include conducting seminars to raise awareness, stimulating information sharing, developing materials such as posters, booklets, and articles, and providing training to both trainers and service deliverers in the identification and treatment of xerophthalmia, blindness prevention, and primary eye care. Key PVOs that have received these services include the Bangladesh Rural Advancement Committee (BRAC), Center for Development Services (CDS), CARE, Voluntary Health Services Society (VHSS), International Union for Child Welfare and the Bangladesh Women's Health Coalition. Both the Association of Development Agencies in Bangladesh (ADAB) and VHSS, the major coordinators of local PVO organizations, have agreed to work with HKI to involve all of their members in support of vitamin A deficiency control and to assist in vitamin A capsule distribution. Finally, BRAC, Cornell University and HKI will collaborate on measuring the effects of nutrition education and VAC distribution on child survival in a project expected to begin later this year.

D. RATIONALE: REASON FOR THE SELECTION OF WHEAT FORTIFICATION WITH VITAMIN A

The rationale for identifying food stuffs which can be fortified with vitamin A lies in the potential for this strategy to eventually eliminate the need for imported vitamin A capsules and to effectively reach and improve vitamin A nutrition among large segments of the population most at-risk of vitamin A deficiency. Frequently, these are groups least likely to be reached by direct interventions such as vitamin A capsule distribution. Thus, the targeting capability and the adequacy with which vitamin A would be provided to high risk groups is critical to its potential success. Fortification of wheat distributed to recipients of food distribution programs will directly improve the vitamin A status of a very high risk group, the poor and landless (see targeting efficiency ratio page 14).

Vitamin A Deficient Population

Vitamin A deficiency is a serious nutritional problem among children in Bangladesh. Nationally, 4.5% or 900,000 children under 6 years of age suffer from xerophthalmia.* (2) Approximately, 30,000 progress to blinding corneal disease (2) making vitamin A deficiency the most important cause of childhood blindness in the country. It has long been known that high mortality attends severe xerophthalmia (15), but only recently has it become apparent (in Indonesia) that even milder stages of vitamin A deficiency carry substantially increased chances of morbidity (16) and mortality (17) among preschool children. Evidence in Bangladesh also links mild xerophthalmia to greater risk of diarrhea (18,19,31), itself a leading cause of early childhood mortality (20). More importantly, it appears that targetd vitamin A supplementation within endemic regions of deficiency can effectively reduce mortality in this vulnerable age group (18).

The poorest children living in the highly distressed areas of Bangladesh are most likely to have vitamin A deficiency and xerophthalmia, the largest proportion of whom live in rural areas. Nearly 80% of all (surviving) blind children examined during the Bangladesh Nutritional Blindness Study were from landless households (4, 22). Children from landless (or near landless) households were at a 2-3 times higher risk of active xerophthalmia than those from landholding households (approximately 11% versus 3.4% respectively). Other characteristics of poverty related to landlessness, such as maternal illiteracy and lack of household ownership of valued

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* "Xerophthalmia" is the ocular disease of vitamin A deficiency including both mild (night blindness, conjunctival xerosis, and Bitot's spots) and severe (corneal xerosis, ulceration, and necrosis) stages of involvement.

FIGURE D.1 GEOGRAPHICAL VARIATION IN PREVALENCE OF NON-CORNEAL XEROPHTHALMIA (BNSB, 1982-83)

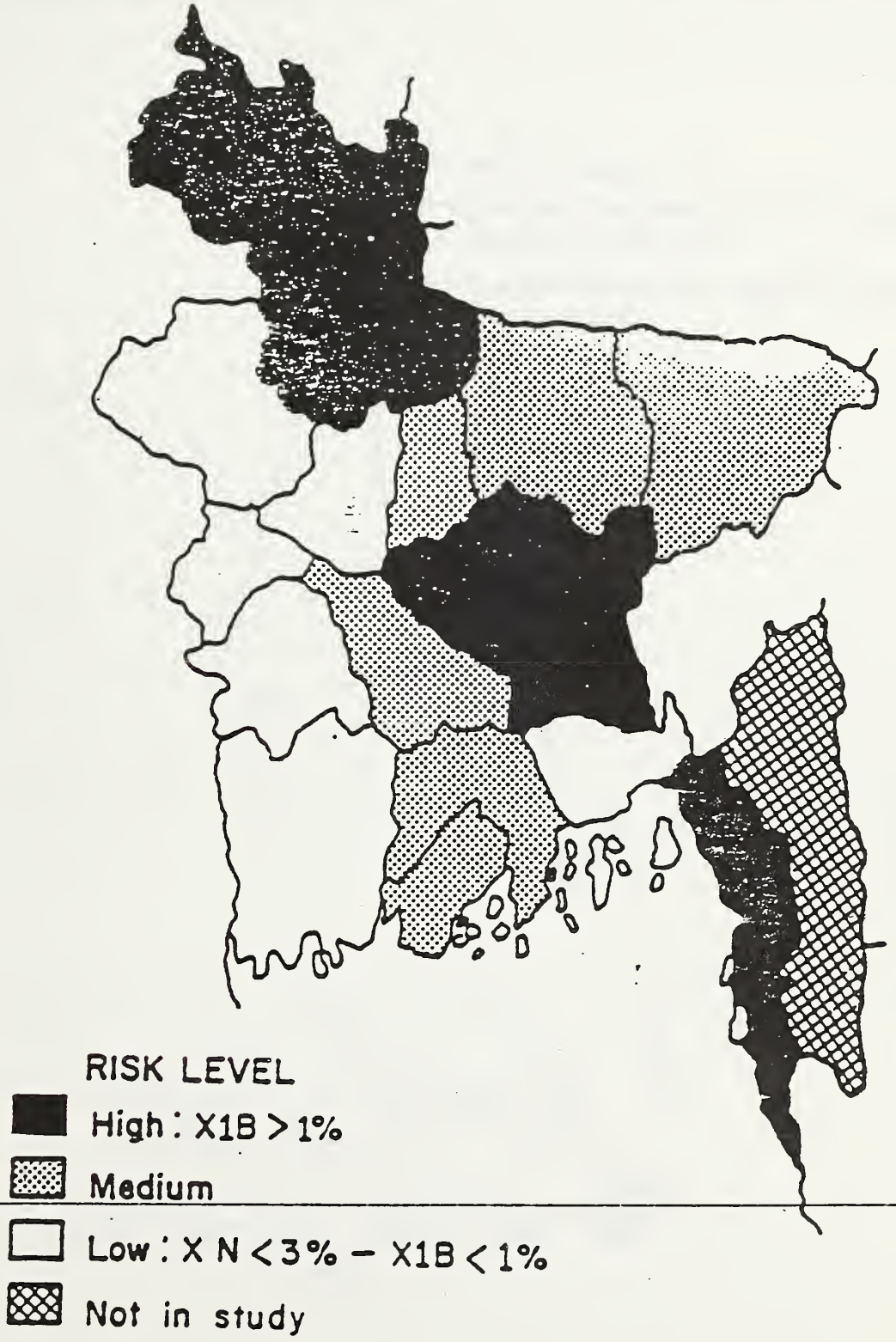
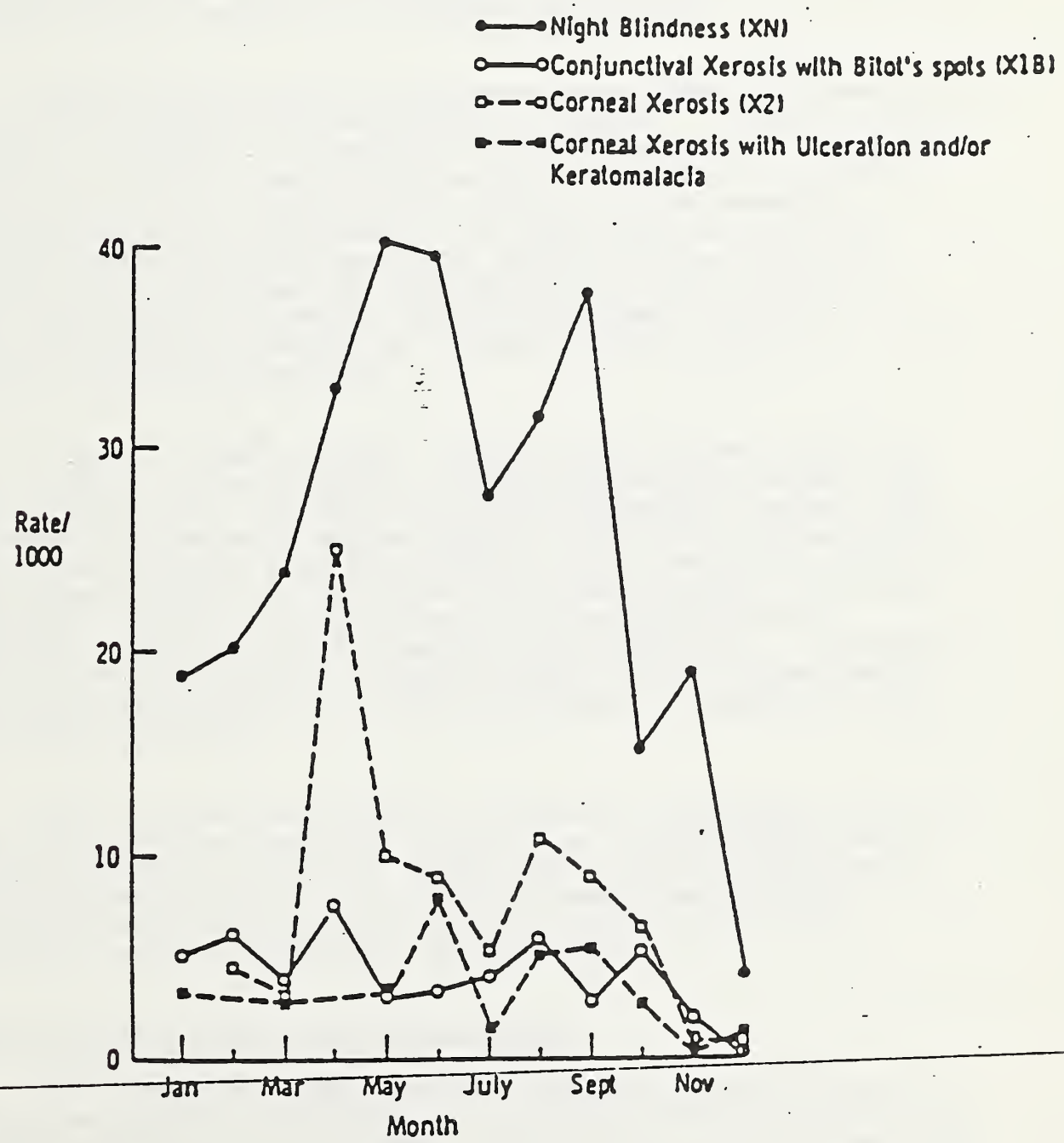


FIGURE D.2 MONTHLY VARIATION IN SIGNS AND SYMPTOMMS OF XEROPHTHALMIA. MALNOURISHED CHILDREN AGED 0-6 YEARS, CHILDREN'S NUTRITION UNIT (SCF-UK) DHAKA, 1979.



articles such as radios, bicycles, wristwatches, or a tin roof atop the house, were all strongly related to xerophthalmia among children (2). These correlates of rural poverty were associated with both mild and severe (corneal) xerophthalmia. Importantly, it is often poor children with xerophthalmia who tend not to receive prophylactic doses of vitamin A during community-based distribution programs (4). The above findings suggest that an intervention preferentially directed toward landless families will achieve more efficient control of potentially blinding vitamin A deficiency than a program which does not utilize this information in defining its target population.

The national survey also demonstrated that the prevalence of xerophthalmia varied considerably by region (8-fold from the highest to lowest) and generally corresponded with recognized levels of ecologic and developmental stress in the country. (see Figure D.1) Specifically, highest prevalences of xerophthalmia were recorded in the same regions with the largest proportions of upazillas officially recognized as "moderately" and "heavily" distressed by a WFP report (23). Thus, geographic targeting also would appear to have a relatively greater impact on vitamin A deficiency for a given level of program resources.

A third, broad ecologic factor with program targeting implications is seasonality. Considerable population (24) and clinical (25, 30) data collected throughout Bengal have shown the pre-monsoon months (April - June) to be the highest risk season of the year for xerophthalmia (see Figure D.2). This time period also coincides, not surprisingly, with the "measles season", itself known to be among the most important risk factors for corneal xerophthalmia. Programs delivering supplemental vitamin A prior to this time period would presumably have the greatest impact on xerophthalmia incidence reduction.

Thus, greater reduction in vitamin A deficiency could be expected by targeting a national vitamin A intervention to young children of landless households, living predominantly in distressed areas of the country, and by employing a schedule which include nutrient delivery prior to the seasonal peak in deficiency (before May).

Wheat Fortification Target Population

Two large food distributions programs already exist in Bangladesh which, in combination, target 20-25 million of the poorest people in the country. Since 1975, the Government of Bangladesh (GOB) has implemented, with World Food Program and CARE assistance, the Vulnerable Group Feeding (VGF) and Food For Work (FFW) schemes which distribute large quantities of grain to poor families either gratuitously or as return for

labor, respectively. VGF routinely provides food to approximately 2.2 million destitute persons (mostly women and children) each month throughout the year and FFW transfers food as payment to approximately 21 million persons (3.5 million workers and their families) mostly during the 4-5 month Food for Work Season (December - April) each year (26).

Although the two programs are distinct in their rationale, organization, design, and coverage, both utilize the same food (largely imported wheat) which moves through the same Ministry of Food (MOF) public foodgrains distribution system, and are complementary in that they reach different poverty-stricken segments of society. VGF specifically targets widowed/separated/deserted/divorced women (or those with a disabled husband), and extremely low income or distressed families, especially those with young children or pregnant/lactating women (27), and FFW provides gainful employment to an otherwise unemployed labor force for several months out of the year (26). Given these joint target groups, the technological feasibility of fortifying wheat, the logistical feasibility of centrally fortifying imported wheat, and the ability to deliver it to high risk beneficiaries through the MOF public grains distribution system, the VGF and FFW programs offer new potential for substantially improving vitamin A status among the nation's poorest 25% of the population.

Recent surveys (27, 28) undertaken to evaluate the VGF program by the WFP (and the FFW program by USAID) suggest that their intended beneficiaries are being reached, and therefore are also likely to be targeting a large proportion of vitamin A deficient individuals in the country. Approximately 90% of VGF beneficiaries are completely landless compared to a national level of 10 - 15%. Further, 65% are living without their husbands and only 10% are literate (compared to 20% nationally for rural women). Among FFW laborers, 57% own no crop land and another 15% own less than 0.5 acres (near landless).

Based on available landholding and prevalence figures, estimates can be derived of the proportion of total xerophthalmic preschool children in the country who live in VGF/FFW households. Among VGF recipients, it is assumed that 25% (or 540,000) of the 2.2 million family members are 1-5 years of age (3% of 18 million same-aged children in the country). Eighty-eight percent come from landless households for whom the prevalence of xerophthalmia is estimated to be 110 per 1000 (4). Therefore delivering vitamin A throughout the year to these 2.6% of the total child population would presumably reach 5.8% of all cases of xerophthalmia presently in the country (52,272/900,000) for a "targeting efficiency ratio" of 2.2 (5.8/2.6).

For the FFW population, it is assumed that 18.2% of the 21 million recipients are 1-5 years of age, of whom 72% (13% of all children in the country) are landless or nearly landless. At a more conservative prevalence estimate of 90 per 1000, 248,000 (or 28%) of the 900,000 cases occur each year in this population for a targeting efficiency ratio of 2.1 (28/13). Thus, each year, vitamin A fortification of all VGF/FFW program wheat would be expected to protect approximately 33% (300,000) of the country's preschool children at highest risk of xerophthalmia by reaching only 16% of the total child population.

This estimate of coverage of highest risk children by wheat fortification is further strenghened at the regional level of analysis. The proportion of total population covered by the VGF, and the average amount of wheat earned by a laborer in FFW, increase directly with the magnitude of the official "stress factor", a composite index of need assigned to each upazilla in the country by the GOB. The largest proportions of upazilas considered to be moderately to heavily-distressed are in Rangpur and Dhaka regions (13), which are also the regions at highest risk for xerophthalmia (4). Thus, xerophthalmia rates are highest in areas of greatest distress which, in turn, have the highest percentages of their populations participating in the VGF/FFW programs.

Taken together, these analyses indicate that vitamin A fortified wheat would reach a large percentage of the vitamin A deficient population while reducing "excess coverage" of the population at less risk of vitamin A undernutrition. Thus, a strong rationale appears to exist for fortifying VGF/FFW wheat, initially on a demonstration basis. If successful, a national strategy may be an effective and appropriate response to partially control vitamin A deficiency among vulnerable preschool children and pregnant/lactating women in Bangladesh.

E. PROGRAM INTERVENTIONS: DESCRIPTION OF PROPOSED PROJECT

1. BACKGROUND

As described in Sections B and D, vitamin A deficiency is a serious problem in Bangladesh. Chronic dietary deficiency of vitamin A among up to 70 million persons results in over 900,000 children under six having some form of xerophthalmia and 30,000 children being blinded each year (4). Of potentially greater significance, recent international research (21) into the effects of vitamin A deficiency suggest that even moderate vitamin A deficiency can lead to higher mortality rates among children, reduced growth rates, and increased susceptibility to and severity of diarrheal and respiratory diseases.

Bangladesh has recognized the importance of this problem, and since 1973, has undertaken a national program to distribute vitamin A capsules to children under six years old. It also has supported programs which encourage consumption of vitamin A rich foods. Although these programs have been successful in reducing the problem, vitamin A deficiency has persisted, particularly among the poorest families and those who are not reached effectively through the existing health infrastructure. Accordingly, HKI has sought additional ways to alleviate vitamin A deficiency by improving the capsule distribution system, expanding the consumption of vitamin A rich foods, and introducing food fortification as a new means for delivering vitamin A to those in need.

(a) Wheat Fortification

In August 1986, HKI studied options for food fortification in Bangladesh (5). Foods which were examined as potential carriers for vitamin A included rice, wheat, sugar, salt, vegetable oil, biscuits, and tea. Of these, only wheat fortification appeared feasible. HKI concluded that imported wheat, which is currently distributed to up to 20-25 million destitute and very low income persons through the Vulnerable Group Feeding Program (VGF) and Food For Work Program (FFW), could be fortified with vitamin A to provide coverage of these otherwise hard-to-reach groups.

During November 1986 - January 1987, HKI undertook additional feasibility studies of wheat fortification. Through a study of the GOB wheat distribution system (6,7), HKI concluded that the existing network of grain silos, storage depots, and grain carriers can be easily and inexpensively adapted to fortify wheat in Bangladesh and deliver the fortified wheat to nearly all the present VGF and FFW recipients. In a second study by HKI (8), it was found that the wheat distributed through the VGF and FFW

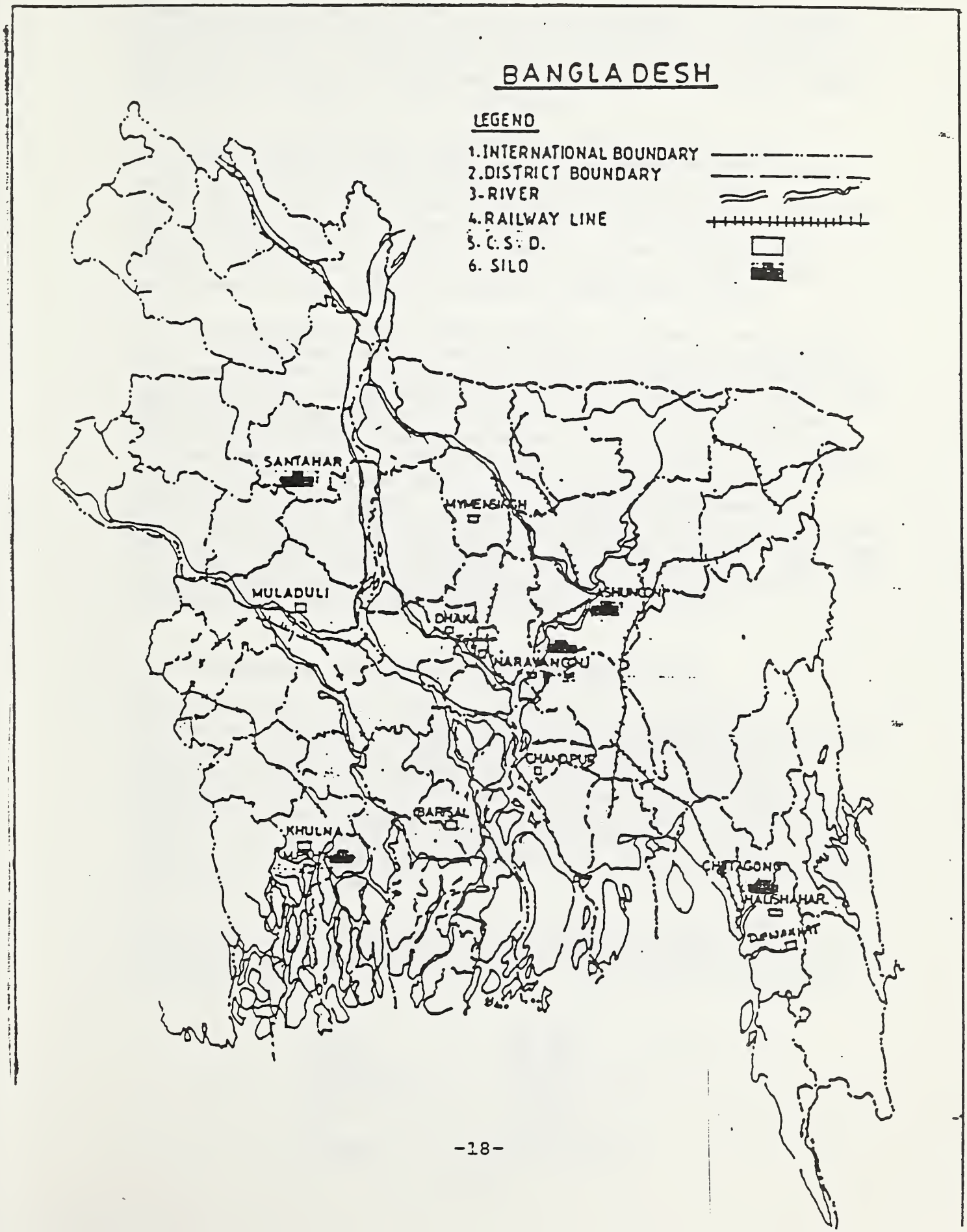
programs is consumed by all family members except infants, and that consumption is largely in the form of chappatis, i.e., flat bread made by baking dough prepared from whole ground flour. These studies, together with other supporting reports (9, 10) strongly suggest that fortification of wheat in Bangladesh is technically and logistically feasible, and that a program to fortify the 650,000 tons per year of wheat used in VGF (170,000 tons) and FFW (480,000 tons) could be expected to have a significant beneficial impact on the families of the wheat recipients.

Analysis of the present wheat distribution system in Bangladesh has suggested that imported whole wheat can be simply and inexpensively fortified at the major wheat handling/storage silos at Chittagong, Narayanganj, Ashugonj, and Santahar (see map in Fig. E.1). The process of fortification requires addition of a small amount (0.5%) of a vitamin A premix to wheat (99.5%) and mixing the wheat and premix to assure a uniform distribution of the premix throughout the wheat. The HKI studies indicated that minimal modifications at the GOB silos can permit fortification of wheat at a rate of 200 tons per hour at each silo, sufficient to supply the VGF and FFW programs. Costs of modification will not exceed US$ 50,000 per silo and recurring costs for extra handling should not exceed US$ 0.25 per ton. The premix, which will provide 10,000 IU of vitamin A per kg. of wheat, is estimated to cost US$ 3.00 per ton of fortified wheat.

The HKI wheat distribution study concluded that for the most part fortified wheat can be distributed to VGF and FFW programs using the existing grain distribution system in which fortified wheat is identified as a new commodity and replaces an equal amount of unfortified wheat. No additional costs will be incurred for distribution of this wheat because it is simply a replacement for a commodity for which distribution costs are already paid.

Wheat used in the VGF and FFW programs is distributed from the four grain silos and the Khulna bagging center through a system of 12 Central Storage Depots (CSDs) and 608 Local Storage Depots (LSDs) which are located at key points throughout Bangladesh. The CSDs and LSDs distribute a total of about 1.5 - 2.0 million tons of wheat per year, which is used in various public food distribution schemes. In addition, the depots distribute several other basic commodities used in the schemes including rice, sugar, salt, vegetable oil, and occasionally, certain other commodities.

FIGURE E.1


BANGLADESH
LEGEND
1. INTERNATIONAL BOUNDARY
2. DISTRICT BOUNDARY
3. RIVER
4. RAILWAY LINE
5. C. S. D.
6. SILO
SANTAHAR
MYMENSINGH
MULADULI
DHAKA
NARAYANGONJ
CHANDPUR
BARISAL
KHULNA
CHITTAGONG
HALISHAHAR
DOUARHAT

Wheat distributed to VGF and FFW recipients is collected from the depots periodically by VGF and FFW representatives and delivered to 4600 Union wheat distribution centers where it is given to VGF beneficiaries on a monthly basis and paid as wages to FFW laborers.

In order to permit the expeditious distribution of fortified wheat rather than ordinary wheat at the Union centers to VGF and FFW recipients, production and distribution of fortified wheat must be planned, scheduled and carried out on a timely basis. While this will require additional effort in managing the program and entail additional record-keeping, it is not projected to represent a significant burden or additional cost.

It is envisioned that a small amount of wheat used in VGF and FFW programs cannot be fortified using the procedures outlined above. Approximately 150,000 tons of domestically produced wheat is procured annually and bagged at CSDs and LSDs and is distributed from the depots in the various wheat distribution center schemes. During certain times of the year, and in certain areas of Bangladesh where wheat is an important crop, some of the LSDs are believed to stock only local wheat. While special arrangements might be made to secure stocks of fortified wheat for those LSDs, the additional expenses of shipping and handling the fortified wheat would probably not be justified. The loss of coverage due to this problem is not known but is probably much less than 10% of the recipients.

(b) Consumption of Wheat by VGF Beneficiaries

The VGF program is a nationwide program to assist distressed women and their children by supplying wheat and providing training in income-generating activities, hygiene, nutrition, health care, and family planning. Recipients are given 31.25 kg. of wheat monthly and are eligible to participate in the program for two years. In 1986-87, the program is scheduled to deliver 171,000 tons of wheat to 450,000 women selected by local VGF committees throughout the country.

Wheat used in the VGF program is donated by the WFP, various bilateral agencies, and the GOB. While the amount and donors vary from year to year, contributions expected in 1986-87 are:

WFP	79,000
GOB	35,000
Canada	30,000
Australia	17,000
EEC	10,000
Total	171,000 MT

The WFP closely monitors the VGF program to assure that its objectives are met and that resources are properly utilized. In a comprehensive WFP report of a 1985 survey of VGF beneficiaries (11), it was concluded:

1. The average VGF family consists of 4.8 people including the recipients, 2.3 children under 12 years old, and 1.5 older children and other adults. 28% of the recipients were either pregnant or lactating. Of the children, 4% were infants, 30% were 1-5 years, and 66% were 6-12 years.

2. The amounts of wheat received by each family averaged 20.71 kg. per month (66% of the prescribed amount). 81% of the recipient families consumed all of the wheat received and the remainder sold all or part of the ration. 7.9% was sold and 92% consumed.

3. Recipients purchased 31.1 kg. of additional wheat and 23.9 kg. rice per month.

Analysis of the findings of the WFP report show that the 450,000 VGF recipients represent a total of 2.2 million food beneficiaries, of whom 41,000 are infants, 311,000 are 1-5 years; 683,000 are 6-12 years, and 126,000 are pregnant or lactating. The daily per capita consumption of cereal grains by beneficiaries was 507 grams of which 131 grams is VGF wheat (26%), 213 grams is purchased wheat (42%) and 163 grams is rice (32%).

The HKI Wheat Consumption Study (8) showed that VGF recipients used their wheat by grinding it to make atta (whole wheat flour) and baking it to make chappatis (flat bread). The study collected information concerning intra-household wheat consumption and found that all household members, except infants, consumed significant amounts of wheat. Table E-1 lists the "Wheat Consumption Index" for VGF family members in various age groups. It shows that children 1-3 years consume 53% of the average per capita amount of wheat, children 4-6 years consume 86% of the average, and adults 20-39 years consume 117% of the average.

Fortification of wheat with 10,000 IU of vitamin per kg of wheat would provide a beneficial amount of vitamin A directly to all 2.2 million VGF recipients. As shown in Table E-2, the average recipient should receive about 480,000 IU of vitamin A per year via fortified wheat. Fortified wheat can provide essentially all of the recommended dietary allowance (RDA) for children 1-9 years (83-112%) and over half the requirements for other family members (53-71%). Infants could also derive benefits from fortification because mothers will share their increased vitamin A intake through breast-feeding.

(c) Consumption of Wheat by FFW Beneficiaries

Food for Work (FFW) is a national program in which wheat is used as payment to laborers for work on roads, water development projects, and other development-oriented public activities. The vast majority of FFW projects are undertaken during the 5-month dry season (December-April), but a small number (9%) are undertaken as post-monsoon road work and a year-round maintenance program for earth roads. Workers are paid on the average 5.0 kg. of wheat per day of work and are selected, supervised, and paid with wheat by local committees. During 1986-87, 480,000 tons of wheat are scheduled to be used in payments for work through the dry season FFW program. It is estimated that the program will result in about 3.5 million workers performing roughly 90 million mandays of work.

Wheat distributed through the FFW program is donated by the WFP, USAID, and other bilateral agencies, and the GOB. As in the case of VGF, the amount of wheat and donors change from year to year, but contributions scheduled for 1986-87 include:

USAID	135,000
WFP	131,000
GOB	100,000
Canada	54,000
Australia	30,000
West Germany	20,000
EEC	10,000
Total	480,000 MT

TABLE E.1

WHEAT CONSUMPTION BY VGF AND FFW FAMILY MEMBERS

Age Group (years)	VGF Intake Index 1/ (Wheat Intake/Avg Intake)	FFW Intake Index 1/ (Wheat Intake/Avg Intake
< 1	0	13 %
1 - 3	53 %	41 %
4 - 6	86 %	72 %
7 - 9	101 %	92 %
10 - 12	104 %	101 %
13 - 15	108 %	114 %
16 - 19	101 %	114 %
20 - 39	117 %	127 %
40 - 49	124 %	124 %
50 - 59	146 %	127 %
>\ 60	105 %	147 %
All	100 %	100 %

1/ "Intake Index" represents the daily wheat consumption of members of an age group divided by the average wheat consumption of all age groups (expressed as a percentage) and reflects the relative proportion of wheat consumed by individuals of various ages.

TABLE E.2

PROGRAM WHEAT CONSUMED AND POTENTIAL VITAMIN A INTAKE

BY VGF AND FFW FAMILY MEMBERS

		VGF			FFW 2/		
Age Group (years)	RDA 1/ (IU vit.A) (day)	Wheat Consumed (kg/yr)	Vit A Rec'd IU/yr)	% RDA Rec'd (%)	Wheat Consumed (kg/5 mo.)	Vit A Rec'd (IU/5 mo.)	% RDA Rec'd (%)
< 1	1000	0	0	0	1.8	18,000	12
1 - 3	833	25.1	251,000	83	5.6	56,000	45
4 - 6	1000	41.0	410,000	112	9.7	97,000	65
7 - 9	1333	48.0	480,000	99	12.5	125,000	62
10 - 12	1919	49.7	497,000	71	13.7	137,000	48
13 - 15	2417	51.2	512,000	58	15.5	155,000	43
16 - 19	2500	48.2	482,000	53	15.4	154,000	41
20 - 39	2500	55.5	555,000	61	17.2	172,000	46
40 - 49	2500	59.2	592,000	65	16.8	168,000	45
50 - 59	2500	69.7	697,000	76	17.1	171,000	46
> 60	2500	50.1	501,000	55	19.9	199,000	53
Average		47.7	477,000		13.5	135,000	

1/ Recommended dietary allowance for vitamin A for Bangladesh Nutrition Survey of Bangladesh, Univ. of Dhaka, Dec. 1983 (12).

2/ Estimates for FFW beneficiaries based on a 5-month of food distribution. Percent RDA is during 5-month distribution period only.

Distribution of food and the amount of work completed by FFW laborers is tightly controlled and closely monitored by WFP and other program organizers. However, the actual number of persons who benefit from the program or the amount of wheat consumed per beneficiary is not definitely known. Based on the limited data available on beneficiaries and consumption practices, "best guess" estimates of relevant family composition and consumption statistics are as follows:

1. The average FFW family consists of 6 people, including 2.5 children under 12, 3.5 older children and adults, and 0.3 pregnant or lactating woman. As in the case of VGF families, it is assumed 4% of the children under 12 are infants, 30% are 1-5 years, and 66% are 6-12 years.

2. The amount of wheat received by each laborer is 5 kg per day of work, and a laborer works on the average 25 days during the 150 day dry season. Of the 125 kg of wheat received as payment for labor, 81 kg (65%) are retained and consumed by the family and 44 kg (35%) are sold or traded for other goods.

3. Recipients purchase additional wheat and rice as required to complete their diet but, on the average, consume 300 grams of wheat per person per day.

TABLE E. 3

Summary of Estimated Beneficiaries of
National VGF and FFW Programs (1986-87)

1. Vulnerable Group Feeding (VGF)

Direct Recipients 450,000

Total Beneficiaries (4.8 per recipient)...2,200,000

Infants.....41,000
Children (1-5).....311,000
Children (6-12).....683,000
Pregnant and lactating women...126,000
Adolescents and other adults...589,000

2. Food for Work (FFW)

Direct Recipients (laborers).....3,500,000

Total Beneficiaries
(6.0 per recipient).....21,000,000

Infants.....350,000
Children (1-5).....2,625,000
Children (6-12).....5,775,000
Pregnant and lactating women..1,050,000
Adolescents and other adults.11,200,000

Based on these estimates, and assuming approximately 10% loss of wheat for payment of supervisors, etc., it can be concluded that the 3.5 million FFW workers provide wheat to 21 million beneficiaries altogether. Beneficiaries include 8.75 million children under 12 years of whom 0.35 million are infants, 2.6 million are 1-5 years, and 6.3 million are 6-12 years. Approximately one million beneficiaries are pregnant or lactating women. The per capita consumption of FFW wheat is 13.5 kg. per beneficiary per work season which represents the full wheat requirements for a 45 day period during the 150 day work season.

As shown in Table E-1, the HKI Consumption Study (8) found that all FFW beneficiaries except infants consumed wheat in significant amounts. The relative proportions of wheat consumped as a percentage for children 1-3 years was found to be 41%, for children 4-6 years was 72%, for children 7-9 years was 92%, and for adults 20-39 years was 127%.

Fortification of FFW wheat with 10,000 IU of vitamin A per kg of wheat would provide a beneficial amount of vitamin A directly to the 21 million FFW beneficiaries during the 5 month work season. As shown in Table E.2, the average beneficiary should receive 135,000 IU of vitamin A during the work season via fortified wheat. Children 1-9 years will receive 45-65 % of their total vitamin A requirements from fortified wheat while other family members will receive 41-53%. Although the program would not supply vitamin A during the 7-month non-work season, it will help assure adequate intake during the critical pre-monsoon period when xerophthalmia and measles are most prevalent among the vulnerable 1-5 year age group.

(d) Safety of Proposed Fortification Levels

Table E-2 provides age-specific group estimates of daily intake of vitamin A that can be expected, on the average, at the calculated levels of wheat consumption (10). Approximately half of the population will probably consume more than this amount at any one time, although the likelihood of sustained, very high daily intake of wheat on an individual basis is low. Twice the daily estimate of intake of wheat would contribute approximately twice the RDA among young children and slightly more than the RDA for adults. Dietary bulk of cereals generally defines the upper limit of their consumption by young children, thus also limiting the risk of over-consuming vitamin A. Among adults, a consistent consumption of 1000 gm of wheat daily (considered an extreme upper range) would provide 10,000 IU per day. This level is considered completely safe and is the recommended level of the World Health Organization and the International Vitamin A Consultative Group for daily supplementation of pregnant and lactating women (29). Thus, the entire expected range of vitamin A is considered safe for the targeted population.

A second consideration is the degree of risk associated with young children consuming fortified wheat routinely and also being periodically dosed with a 200,000 IU dose of vitamin A (UNICEF capsules) every six months. This latter intervention is widely recognized as the standard high dose supplement for preventing xerophthalmia and is intended to "top off" existing, generally low intakes in the diet. Currently, approximately 42 million UNICEF capsules are distributed to children each year in Bangladesh. There is no evidence to suggest that taking a semi-annual prophylactic dose of vitamin A is a contra-indication for consuming a daily amount of vitamin A that approximates a child's requirement.

(e) Summary

Fortification of VGF wheat with 10,000 IU of vitamin per kg of wheat would provide a beneficial amount of vitamin A directly to all 2.2 million VGF recipients. As shown in Table E-2, the average recipient should receive about 480,000 IU of vitamin A per year via fortified wheat. Fortified wheat can provide essentially all of the recommended dietary allowance (RDA) for children 1-9 years (83-112%) and over half the requirements for other family members (53-71%). Infants could also derive benefits from fortification because mothers will share their increased vitamin A intake through breast-feeding.

Fortification of FFW wheat with 10,000 IU of vitamin A per kg of wheat would provide a beneficial amount of vitamin A directly to the 21 million FFW beneficiaries during the 5 month work season. As shown in Table E.2, the average beneficiary should receive 135,000 IU of vitamin A during the work season via fortified wheat. Children 1-9 years will receive 45-65 % of their total vitamin A requirements from fortified wheat while other family members will receive 41-53%. Although the program would not supply vitamin A during the 7-month non-work season, it will help assure adequate intake during the critical pre-monsoon period when xerophthalmia and measles are most prevalent among the vulnerable 1-5 year age group.

Fortification of all of the 650,000 tons per year of wheat used in VGF and FFW programs would be expected to benefit over 23 million of the most needy persons in Bangladesh. A summary of estimated beneficiaries is given in Table E-3. A projection of costs to fortify all VGF/FFW wheat is found in Appendix D. (For a brief discussion on recurring costs and national program potential see Appendix D.)

2. DEMONSTRATION PROJECT

Although wheat fortification is simple, straightforward, and would be expected to have a substantial nutritional impact, it is prudent for the GOB to demonstrate the operational feasibility and the nutritional impact of the program on a limited scale before launching a full-scale national program. A demonstration project is needed to verify that the following objectives can be met:

- fortification of wheat can be carried out effectively in Bangladesh grain storage/handling silos using the technology outlined in this proposal.

- fortified wheat can be transported in bulk and/or in bags from silos to other silos, CSDs, LSDs, and Union wheat distribution centers with only minor adjustments in the public food distribution system.

- fortified wheat will be consumed in significant amounts by VGF and FFW beneficiaries and as a result, vitamin A deficiency will be decreased in Bangladesh.

- the production and distribution of fortified wheat can be controlled and monitored adequately.

- the start-up and recurring costs of the fortification are within estimated levels.

HKI proposes to carry out a limited wheat fortification demonstration project in which wheat is fortified in one silo, the fortified wheat is distributed to VGF and FFW beneficiaries in an area where there is a high prevalence of xerophthalmia, and the production, distribution, and nutritional impact is closely monitored over a period of at least one year.

(a) Project Site

It is proposed that wheat used in the demonstration project be fortified at the Chittagong silo, shipped in bulk to the Narayanganj silo for bagging, and the bagged, fortified wheat distributed to selected CSDs and LSDs in the Dhaka Division which are normally supplied with wheat from the Narayanganj silo. The CSDs and LSDs will be in districts where the Bangladesh Nutritional Blindness Study (4) has shown xerophthalmia to be especially severe. The wheat will be distributed in upazillas through approximately 200 Union distribution centers across diverse areas of Dhaka Division. A small number of Union wheat distribution centers which receive fortified wheat and a corresponding number of centers which do not receive fortified wheat will be selected for nutritional impact monitoring and evaluation (see Section H).

Chittagong silo was selected as the site for fortification because it can, if necessary, provide fortified wheat to any part of Bangladesh at minimum expense. The requirements for the entire VGF program (170,000 tons per year) could be met by Chittagong. For example, if it were determined, based on the demonstration project, that FFW wheat should not be fortified, no additional fortification processing systems at other silos would be required to meet the national requirements of the VGF program. However, if/when a decision is made to expand the program throughout Bangladesh, fortification at Chittagong could be readily expanded to cover other parts of the country.

The Narayanganj silo was selected as the site for bagging and distribution because the Bangladesh Nutritional Blindness Study showed the areas serviced by Narayanganj are among the most severely affected with xerophthalmia and because the Narayanganj service area is near Dhaka where the project's primary managing and monitoring personnel are stationed. Fortified wheat will be bagged at Narayanganj rather than Chittagong in order to verify the feasibility of shipping fortified wheat in bulk, as would be required in a full national program, and otherwise to make the demonstration project operationally similar to a full program.

During the demonstration project, wheat will be fortified and distributed at a rate of approximately 30,000 tons per year which is roughly 5% of the annual requirements of the combined VGF and FFW programs. Fortification at this level will provide sufficient project activity to demonstrate performance and assess impact while maintaining a manageable size.

The proposed annual rate of fortification will entail:

-- Procurement of 150 tons per year of vitamin A fortification premix.

-- Operation of fortification processing system 150 hours.

-- Bagging and distribution of 350,000 bags of fortified wheat.

-- Delivery of 8,000 tons of fortified wheat to 20,000 VGF recipients representing 96,000 beneficiaries.

-- Delivery of 22,000 tons of fortified wheat to 175,000 FFW laborers representing 1,050,000 beneficiaries.

It is estimated that the fortified wheat distributed in the demonstration project will reach approximately 5% of the total VGF/FFW beneficiaries and therefore affect the following:

VGF - 96,000 Beneficiaries including:
15,640 infants and children <6 years
5,600 pregnant and lactating women

FFW - 1,050,000 Beneficiaries including:
148,750 infants and children <6 years
52,000 pregnant and lactating women

Infants and children represent the target group at highest risk of severe consequences of vitamin A deficiency. However, pregnant and lactating women are also at risk and this project directly benefits them, whereas the high dose supplemental program is contra-indicated for this group. In addition, these poor and landless VGF/FFW recipients represent a high risk and hard to reach target group.

(b) Fortification and Distribution of Wheat

Vitamin A premix will be procured from a U.S. supplier and shipped in bags or drums to the Chittagong silo. Shipments will be made quarterly in order to reduce storage time and minimize losses of vitamin A potency. Vitamin A fortified wheat should be consumed within not more than one year from the time premix is made in order to prevent excessive loss of vitamin A potency.

The Chittagong silo will be modified to permit fortification of wheat at a rate of 200 tons per hour. Modification requirements are minimal and easily within the capabilities of current silo engineering standards. Modifications will include the installation of a continuous feeder (e.g. W & T Self-powered Dry Flow Feeder) at the bottom of one of the 175 ton half-star bins to feed premix at a rate of one ton per hour. Unfortified wheat will be discharged from the 750 ton round bins at a rate of 200 tons per hour onto a transfer belt where it will be combined with premix. No modification of the wheat bin discharge or transfer belts are required. A continuous mixer (e.g., an S. Howe Eureka continuous ribbon mixer) will be installed after the transfer belt and before the discharge into a second 750 ton round bin in order to assure uniform mixing of premix and wheat. The wheat in the second bin will be fortified and ready for shipment in bulk or, if desired, it can be transfered to a bagging bin from which it can be discharged for bagging in specially marked 85 kg. gunny bags. No other modifications are required at the Chittagong silo. The costs of modifying the Chittagong silo are expected to total $60,000 for engineering, equipment and installation, and training. Delivery and installation of equipment will require up to 9 months.

In order to assure that the fortification process performs satisfactorily, tests will be done initially by mixing wheat with 0.5% of a tracer, such as a foreign seed (like sorghum), and assessing uniformity of mixing by counting the tracer in samples collected after fortification. During actual fortification, the process will be monitored by periodic samples which will be tested for proper fortification at the silo by counting the grains of fortified premix (which are visible under ultraviolet light). Additionally, less frequent samples, will be sent to the Institute of Nutrition and Food Science (INFS) for vitamin A analysis to confirm the validity of the tests at the silo.

Fortified wheat will be transferred to the Narayanganj silo where it will be bagged and shipped to CSDs, LSDs, and Union wheat distribution centers. Bagging will take place in standard gunny bags which will be distinguished from regular wheat bags by using a distinctive color stripe on the side (e.g. orange rather than the usual blue stripe). During the demonstration project, the fortified wheat will also be tagged by placing a cardboard tag in the sewn closure which identifies the batch/date of fortification for purposes of monitoring.

Fortified wheat will be treated as a "new" commodity in the silos and storage depots and separate records maintained concerning sources, stocks, distribution, etc. It will be managed using the same procedures and controls as are being used for regular wheat program movements, and with the same documentation of commodity movement. The system now handles wheat, several categories of rice and other commodities and is able to control fortified wheat. No additional costs are expected for handling, reporting, and monitoring in the distribution system.

(c) Monitoring

During the implementation of the demonstration project, project personnel will monitor (i) the process of fortification, (ii) distribution of fortified wheat, and (iii) consumption and nutritional impact of fortified wheat. Monitoring procedures and monitoring activities will be undertaken by Bangladesh organizations selected through requests for proposals and working through contracts with HKI under HKI direction. Costs for monitoring are estimated to be:

Fortification Processing	$ 5,000
Distribution of Fortified Wheat	$ 80,000
Consumption and Impact	$ 97,000
Total	$ 182,000

(See Section H for further detail on monitoring activities)

(d) Project Management and Evaluation

HKI will provide overall management of the demonstration project. HKI's Country Director Mr. Anthony Drexler, will serve as Project Director. He will be assisted by a full time Project Manager who will be identified and hired in the initial month of the project and who will be an employee of HKI/Bangladesh. HKI's technical advisor, Dr. Ian Darnton-Hill, a physician with extensive public health and nutrition background, will serve as technical advisor to the project, especially during consumption and nutritional impact evaluation. The resumes of the current and proposed HKI Bangladesh staff are in Appendix B.

A project Advisory Committee will be created and will have members representing the Ministries of Health, Relief and Rehabilitation, and Food, USAID, the World Food Program, CARE, the Bangladesh Programme for the Prevention of Blindness, UNICEF, the Bangladesh Rural Advancement Committee, HKI and others. The Advisory Committee will serve as an interface between the project and the various organizations involved in or interested in the project.

HKI will prepare quarterly progress reports during project implementation which will be distributed to USAID/Dhaka and to other interested organizations. Special reports will be issued upon completion of key activities.

The project will be evaluated (a) after the first year when the base line study has been completed, and (b) after the second year when monitoring of distribution and nutritional impact has been completed. The evaluation teams will be selected jointly by HKI and USAID/Dhaka.

(e) Duration of Project

The total duration of the demonstration project will be 30-36 months. Start-up time will be approximately one year to procure, install and test fortification equipment, procure fortificant, develop procedures and manuals, train operational and monitoring staff, undertake a baseline study for impact assessment, and establish the Advisory Committee and operational linkages.

Wheat fortification will commence after start-up activities have been completed and preferably sometime during May-October when distribution of wheat is at its lowest rate. Distribution and monitoring will continue for a minimum of one full year to assess the operational procedures and demonstrate impact. Modifications in procedures will be made if necessary to improve operations.

Upon completion of the one-year operational cycle, an analysis of monitoring data will be made to measure achievement of project objectives, and to provide a basis for recommendations for continuation and expansion of the project to a national program. A period of 6-12 months will be required for analysis and decision-making. The demonstration project will provide resources to continue fortification in the test area during this period in order to prevent a long hiatus.

F. FACTORS CRITICAL TO THE SUCCESS OF THE PROJECT

1. Coordination and cooperation among implementing agencies

A large number of government ministries, local organizations and donor organization will have important roles in the project. While the major burden of implementation will reside with the Ministry of Food, which will be responsible for fortification and distribution of the wheat, all the groups will need to cooperate in a coordinated implementation plan. HKI recognizes the critical nature of coordination and will establish a Coordinating Committee and reporting system to help insure good communication and cooperation among the project participants.

2. Fortification technology

The technology for fortifying whole wheat with vitamin A using a premix of nutrient-coated grains is based on a well-established technology used to fortify rice with vitamins and minerals. The technology has been applied experimentally to the fortification of whole wheat with vitamin A, but it has not yet been practiced in food distribution programs. In order to assure that the proposed technology for wheat fortification is practical and effective, HKI has entered into an agreement with the US Department of Agriculture (USDA) which works with and is supported by AID/ST/Nutrition, to provide technical assistance for adapting rice fortification technology to fortification of wheat in Bangladesh. USDA will arrange for development of specifications, production of test lots of fortification premix by commercial organizations, and testing for stability and acceptability prior to implementation of the project.

3. Operational effectiveness of the program

The proposed demonstration program has been designed specifically to put in place practical operational procedures, monitor and refine them, and assure that the procedures are appropriate and logistically feasible for a targeted fortified wheat distribution program at both pilot and larger scale.

4. Impact on FFW recipients

As noted in Section D and E.1.b, it is clear that fortified wheat should have a substantial impact on vitamin A deficiency among VGF recipients who receive fortified wheat year-round. Impact on FFW recipients

is less certain because data on wheat consumption among FFW fammilies are not as well defined and because FFW receive smaller amounts of wheat over a shorter time. The demonstration project is designed to obtain more information concerning impact of wheat fortification on FFW recipient families through wheat distribution and consumption studies.

5. Non-duplication of capsule distribution

While the vitamin A capsule distribution program in Bangladesh has limited coverage among the poorest families, a certain amount of overlap between capsule distribution and the proposed VGF and FFW fortification programs is bound to take place. Documented, excessive overlap could provide justification for decreasing capsule distribution. Therefore, the distribution of capsules among VGF and FFW workers will be assessed during monitoring of the demonstration project. Also, WFP has agreed to address this issue in its annual VGF program survey. However, in such a deficient population as Bangladesh, large dose capsules improve vitamin A status in children for only 1-3 months. Both consistent daily intake and periodic large doses would be beneficial and complementary in this population.

G. HKI MANAGEMENT AND SUPPORT

Background and Objectives of the Agency

Helen Keller International (HKI), founded in 1915 by Helen Keller and other Americans to aid allied military personnel blinded in World War I, is one of the oldest U.S. humanitarian organizations involved in international technical assistance and development. It is the oldest U.S. voluntary organization committed to solving the worldwide problems of eye disease and blindess.

Through the years--first in Europe, later in Asia, Latin America and Africa--HKI successively introduced braille printing, education and rehabilitation services for the blind and as of 1972, blindness prevention. In 1972, HKI chose vitamin A deficiency as its first focal point in blindness prevention. A major cataract initiative and a comprehensive primary eye care approach have been added since 1982.

HKI's priority is public health. The major program emphasis is to prevent blindness and eye disease through primary level systems while also continuing to implement programs to rehabilitate and educate those already sightless. HKI programs are designed to:

- Make the greatest possible impact;
- Meet key technological and programmatic needs;
- Demonstrate innovative approaches in the application and adaptation of existing technology;
- Act as a "bridge" between the development of new technology and its application within the socioeconomic framework in developing countries; and,
- Attain replicability within governmental, international and national institutions.

Experience with Health Projects

HKI's field programs embody one or more of the aforementioned principles. HKI's basic approach is to provide technical and managerial assistance, staff, funds, equipment and supplies to governments or NGO's active in or responsible for blindness prevention programs. HKI serves as a technical advisor and as a catalyst. It's role is invariably integrated into the country's overall health policy objectives and is developed as part of a network of collaborating institutions.

Field activities are designed to be innovative, cost-effective interventions which emphasize integration and the wide dissemination of program results in order to promote replication.

HKI addresses those diseases which cause blindness or decreased vision within the broad context of primary eye care by integrating its strategies into existing primary health care systems. Local profesional and paraprofessional health workers, largely governmental, are trained and equipped to prevent or treat conditions likely to occur in the population they serve. For cases that cannot be treated by these local workers, an expanded structure that provides both logistical and referral support is established.

HKI's current prevention programs concentrate on the major causes of avoidable blindness, infectious disease (trachoma), xerophthalmia (nutritional blindness caused by vitamin A) and catatact. In 1972, when HKI's mandate was expanded to include blindness prevention, xerophthalmia was selected as the program focus. HKI has become one of the major institutions involved in promoting prevention of vitamin A deficiency and has played a key role in expanding the knowledge of its etiology and distribution, its prevention and treatment, and, recently, its important linkage to infectious disease and child mortality. HKI is uniquely qualified to undertake a major effort to prevent and treat vitamin A deficiency. Since 1973, HKI has greatly strengthened its technical activities in vitamin A supplementation and nutritional blindness program planning, epidemiology and evaluation, and the agency has achieved significant programmatic advances in Asia, Latin America and Africa. HKI's staff in the field and at headquarters as well as its network of consultants reflect the mandate to serve in a technical assistance capacity. All professional staff have advanced degrees in public health related fields. (See CV's in Appendix B).

INDONESIA

In 1976, with major funding from AID and in collaboration with the World Health Organization and UNICEF, HKI initiated in Indonesia the first major longitudinal research study of the etiology and distribution of vitamin A deficiency. The results of this three-year effort added greatly to the knowledge of vitamin A deficiency and provided important data on more efficient ways to provide access to treatment. Particularly noteworthy was the determination that oral dosing of children (200,000 International Unit vitamin A capsules) as opposed to treatment with injections, was cheaper, considerably less complicated and dangerous and equally effective.

As a result the scientific community was able for the first time to make more accurate estimates of the scope of vitamin A deficiency and blindness (WHO estimates that in Asia alone 250,000 children are blinded each year and in Indonesia the figure is 60,000 children each year), and the Government of Indonesia (GOI) established prevention of nutritional blindness as a major health priority. HKI was requested to assist in the design of a national strategy. With a financing grant from USAID Jakarta in 1978-79, HKI began working with GOI to design and establish a surveillance system and to expand vitamin A capsule distribution, nutrition education and to explore food fortification.

In 1978, HKI, the GOI and the International Center for Epidemiologic and Preventive Ophthalmolgy of Johns Hopkins University (JHU) undertook research which produced the major evidence linking even mild vitamin A deficiency to increased child mortality and morbidity.

In 1982, HKI again in collaboration with JHU and the GOI undertook a two-year field study in Aceh, Sumatra which demonstrated that vitamin A supplementation dramatically reduced mortality and morbidity in children.

In 1985 and 1986 HKI received child survival grants from the office of FVA/PVC to integrate vitamin A supplementation with immunization and ORT programs.

BANGLADESH

In Bangladesh HKI has worked closely with the Government's National Blindness Prevention Program. Since 1976, HKI's efforts in Bangladesh have been aimed principally at improving the effectiveness of vitamin A capsule distribution and in the training of health care workers in diagnosis and treatment of severe vitamin A deficiency.

In 1983 HKI completed a national xerophthalmia/nutrition survey. The study examined the nutritional status of 20,000 preschool children. It showed that eight million children aged one to six years were receiving capsules, a coverage rate of 46 percent based on a target population of 20 million children. The study yielded significant data with regard to when, where and which children are most at risk of vitamin A deficiency, findings which are key to ongoing operations.

Since 1985, HKI with financial support from FVA/PVC and in collaboration with UNICEF developed training programs for 26,000 primary health care workers. HKI is assisting the BPPB in establishing a monitoring and evaluation system which will enhance the program's flexibility and ability to target high-risk groups.

Furthermore, HKI is serving as a technical resource to VHSS and ADAB, two umbrella groups representing several hundred local and international PVO's.

PHILIPPINES

In the Philippines, HKI has developed a multi-regional program which focuses on training and testing of alternative methods for vitamin A delivery.

HAITI

In 1974, the Government of Haiti, with HKI's technical support, carried out a survey to determine the prevalence and geographic distribution of xerophthalmia, the results of which revealed widespread vitamin A deficiency. Based on these findings, in 1976 HKI with AID and UNICEF support developed and implemented a nationwide vitamin A capsule and nutrition education program.

Evaluated in 1979 and again in 1983, the program was a qualified success. The rate of vitamin-related corneal destruction had decreased significantly. While vitamin A supplementation continues in Haiti today it has suffered from a lack of consistent supervision. Local agencies, mainly PVO's are however, anxious to incorporate vitamin A into expanded child survival programs. In 1986, HKI began a collaborative venture with the Haitian Arab Center in Cité Soleil, a huge urban slum outside of Port-au-Prince. The program focuses on developing a vitamin A supplementation strategy for the children in Cite Soliel and developing a training module to be incorporated into a new Institute of Public Health.

EAST AND WEST AFRICA

HKI has greatly intensified its vitamin A efforts in Africa. In 1985 due to the drought, extremely high rates of vitamin A deficiency have been found. HKI moved quickly to assess the problem and implement programs: 2 1/2 million megadoses of vitamin A were delivered to those at risk. Training sessions on prevention and treatment of vitamin A deficiency were conducted in refugee and displaced persons camps in Sudan and Ethiopia. The emergency intervention led to a look at longer-term solutions, not only in those two countries but also in the other major drought affected Sahel countries.

Since 1983, HKI has completed surveys in Senegal and Malawi and more recently in Burkina Faso, Chad, Mali and Niger. In Ethiopia, Sudan, Burkina Faso, Malawi, Chad, Mali and Niger, HKI has, upon requests made by governments, international organizations, and PVO's offered technical assistance in areas such as vitamin A procurement, need assessments, training and impact evaluations.

With generous support from AID, UNICEF, USA for Africa, Live Aid/Band Aid, as well as the corporate sector, and in close collaboration with governments and other NGOs HKI has been able to develop programs in Burkina Faso,Mauritania, Niger, Sudan, Ethiopia and Malawi.

In addition to these country-specific efforts, HKI has played an important role in defining generic strategies to control widespread vitamin A deficiency. Since the 1976 founding of the International vitamin A Consultative Group (IVACG) HKI has played an active role in its deliberations. The result has been recommendations with regard to safe use of vitamin A and the evaluation of selected intervention strategies. Also, with AID support, HKI has developed and field tested current, state-of-the-art training manuals for field workers, physicians and opthalmologists concerned with xerophthalmia. These materials as well as reports and facts sheets have been widely distributed to countries, institutions and individuals around the world as part of HKI's mandate to promote the dissemination of information.

H. IMPACT EVALUATION AND MONITORING SYSTEM

Evaluation activities will be implemented in three components to address:

(a) monitoring the logistics of fortification within a demonstration project area (several districts) serviced by one silo (e.g., Narayanganj),

(b) assessing the impact of wheat fortification on vitamin A status by carrying out a community intervention trial within a single district of the demonstration area, and

(c) separately assessing the intake of program wheat by FFW recipient families. The community intervention trial will be carried out from May 1988 through May 1989.

(a) Project Monitoring

Both VGF and FFW distribution systems will undergo intensive systems monitoring for a 12-month period (e.g., May 1988 - May 1989). At each point along the distribution network (silo, storage, LSD/CSD, union levels) samples of fortified wheat will be collected and analyzed for potency. Records of amounts of wheat shipped, fortified, bagged and delivered through tagging and reporting systems.

(b) Project Impact Evaluation

Assessment of the impact that wheat fortification may have on vitamin A status will be carried out only among VGF children 1-5 years of age for the following reasons:

1. VGF program beneficiaries form the poorest and nutritionally most vulnerable sector of public foodgrains recipients (28);

2. 1-5 year old children are the highest risk age group for vitamin A deficiency and its sequellae (4, 15-19);

3. VGF beneficiaries receive a relatively constant, monthly quota of wheat over a sustained length of time (2 years eligibility);

4. VGF beneficiaries are officially enrolled into the program and records of wheat receipt are strictly maintained at the union level providing a reliable sampling frame for a baseline and follow-up survey enumeration.

In contrast, FFW recipients appear marginally better off economically, receive wheat only during the FFW season (although considerable evidence suggests extended consumption of earned wheat), and are enrolled on-site only at the time of work initiation. Participation may vary from year to year, making sample frame definition, selection and follow-up extremely difficult. As a consequence, evaluation of FFW beneficiaries during the demonstration period will be limited to dietary assessment of program wheat intake and night blindness assessment in the same district as the trial during the post-FFW, high xerophthalmia season (e.g., April-May, 1988 baseline survey). Impact of fortification on vitamin A status will be inferred from intake levels of program wheat based on results of the VGF impact evaluation.

Specific Aim

The primary goal of this evaluation will be to verify that vitamin A-fortified wheat consumption can reduce by at least 50% over a 12-month period the levels of xerophthalmia and physiologically significant vitamin A deficiency among VGF program children 1-5 years of age.

Design

A 12-month community intervention trial will be carried out in one selected district from May 1988 through May 1989. Figure H-2 depicts the basic design of the trial. The Narayanganj silo will be the sole source for all VGF program wheat utilized for the community trial. Selection of the district for the evaluation trial will be based on its rated level of distress, estimated level of xerophthalmia, size in terms of numbers of union VGF distribution centers, numbers of enrolled beneficiaries, general level of Upazila parishad commitment throughout the district to support the evaluation, and access. All CSD/LSDs located within the district (usually one in each upazila) will be requested to serve as local go-downs for storing both fortified and regular VGF wheat during the trial, under the direction of the district food comptroller. Program wheat is normally transported directly to a CSD/LSD from the silo. Unions then draw their monthly VGF requirement from a designated CSD/LSD within their respective upazilla. There are between 7-24 unions per upazilla in Dhaka Region.

A Union center list will be compiled for each upazilla in the district which summarizes the most recent data on numbers of VGF and FFW beneficiaries as well as the principle CSD/LSD from which program wheat is lifted and percent of time used (Table H-1). Only unions which receive lift 90% or more of their program wheat from a single CSD/LSD will be eligible to participate in the formal trial.

Referring to Fig. H-2, the Union center will be the unit of randomization. Once enrolled, each union will be randomly allocated (blocked for upazilla) to receive either the vitamin A-fortified (solid path) or regular wheat (dashed path) wheat for their VGF program throughout the trial period. Bags of each type of wheat will be designated by one of two different colored stripes on the outside of the bags. Each CSD/LSD will receive established quotas of each of the two colored bags of wheat. Unions will be issued bags of VGF wheat each month according to their randomly allocated color scheme. Objectivity requires that every effort be made to mask VGF recipients, all wheat handlers in the district, as well as project evaluation survey teams from the identity of the wheat. Thus, the color code that identifies which bags contain vitamin A and which do not will be known only by a few key, trained and sensitized staff of the Narayanganj Silo who will not be involved in transport or local distribution of the wheat or evaluation of the project.

Two community ophthalmic surveys, carried out 12 months apart in all participating unions, will provide the basis for evaluating program impact. Differences in the rates of xerophthalmia (assessed both by clinical and conjunctival histologic indicators) will be compared between vitamin A fortified and regular wheat recipient children 1-5 years of age at baseline and follow-up (mixed longitudinal sample). The principle question to answer will be whether wheat fortification with vitamin A reduces the occurence of xerophthalmia (i.e., improves vitamin A status in the population) within the usual ranges of wheat intake.

Procedures

Prior to baseline, a preliminary review and verification of union VGF master lists will be carried out by project field staff in collaboration with union officials. Forms will be developed, field tested, refined and printed. Necessary data entry programming will be carried out. Local MOF and MRR staff will undergo training concerning the specific procedural requirements for the evaluation. Field team and data management staff will undergo training and standardization. A complete manual of operations will detail all procedures associated with the community intervention trial and its evaluation.

TABLE H-1

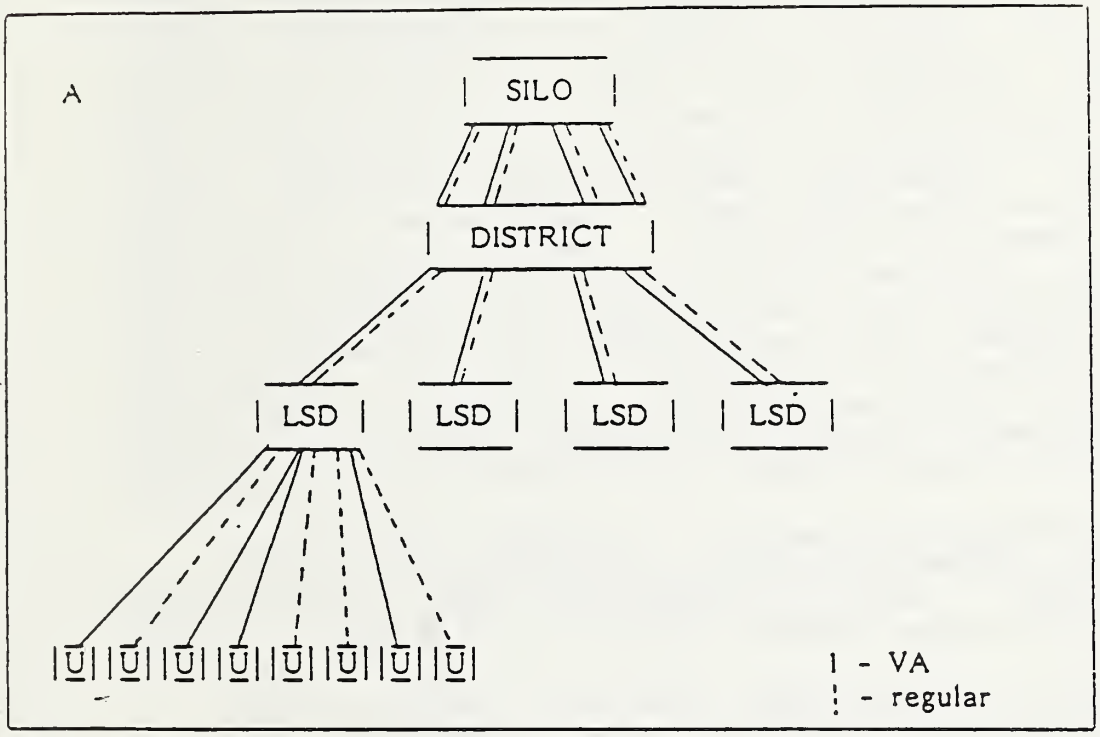
SAMPLE UNION CENTER LIST

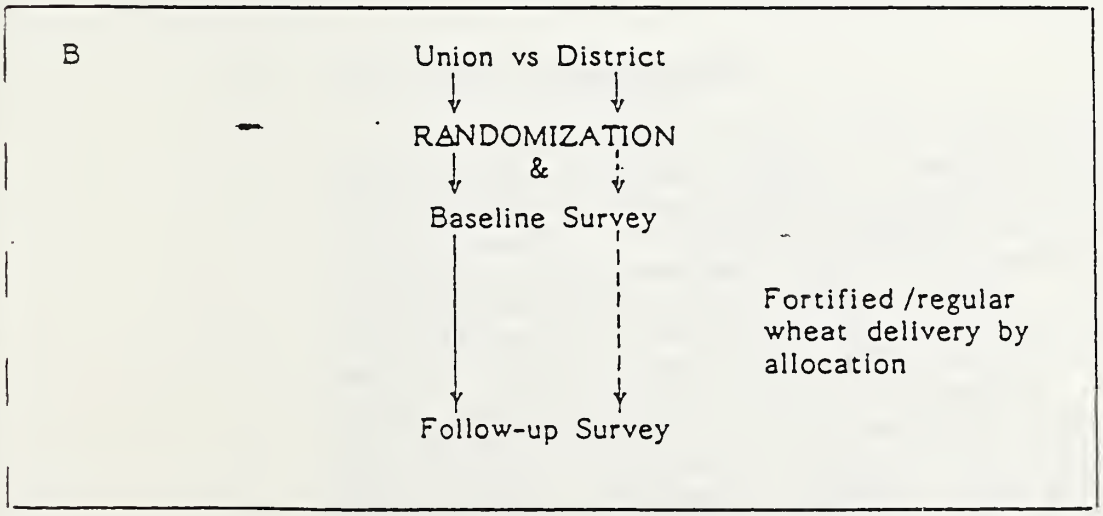
District: Narsingdi (Dhaka Region, No. 63)

Upazilla/ Union No.	Upazilla/ Union Name	1981 Pop.	# Families (1986/7 VGF	# Workers (1986/7 FFW)	Usual CSD/LSD Name	% time used
6301	Balaboo	(census)	175	(number)	(name)	(%
630101	Amlabo	-	25	"	"	"
630102	Bajnabo	-	25	"	"	"
⋮						
6302	Manohardi	-	425	"	"	"
630201	Banachapa	-	34	"	"	"
630202	Amdia	-	25	"	"	"
⋮						
6303	Narsingdi	-	350	"	"	"
⋮						
6304	Palash	-	125	"	"	"
⋮						
630605	Putia	-	50	"	"	"

FIGURE H.2

FLOW OF WHEAT DIAGRAM





A baseline survey of approximately 3000 eligible VGF program families living in 60-80 unions will be carried out during March - May 1988, which corresponds to the early peak season for xerophthalmia. (See Appendix A for sample size calculations.) Beneficiary families will be interviewed and undergo dietary assessment in their homes which will concentrate on daily consumption of all wheat, VGF wheat, and food sources of vitamin A by the family, mother, and 1-5 year old children. Selected morbidity data will also be collected. Mothers with their children will be escorted to a central site (e.g., union center) where enumerated 1-5 year old children will be given an ocular examination and nutritional assessment. Impression cytology will be included in the ocular exam for a 20% systematic subsample of all children. Distribution of wheat by union allocation status will subsequently take place. Throughout the year, a specially-designated project field coordinator will continually monitor all CSD/LSDs and union centers to ensure availability of wheat and adherence to allocation procedures. During March - May 1989, a follow-up survey will be carried out during which all VGF children in sampled unions will be re-enumerated and examined following the same survey protocol.

Conjunctival impression specimens during each survey will be routinely transported to a local laboratory, fixed, stained, and read under light microscopes in Dhaka. Similarly, all collected data will be entered, edited, and analyzed in Dhaka.

During analysis, baseline comparability of groups will be assessed. Outcomes of major interest will be the percent reductions at follow-up in clinical xerophthalmia and abnormal goblet cell profiles among vitamin A-fortified wheat compared to regular wheat consuming children. Secondly, levels of usual program wheat consumption will be estimated to use as the basis for adjusting the fortification level and inferring impact in an expanded program within these ranges of intake.

(c) FFW Dietary Assessment

During the baseline survey from April-June 1988, a multi-stage cluster sample of approximately 200 FFW families will be visited by trained project interviewers. Household members will be enumerated, selected socio-economic data collected and a dietary questionnaire will be administered. Dietary assessment will be directed toward quantifying family, mother, and 1-5 year old child daily consumption of wheat (particularly from the program), as well as food sources of vitamin A. In addition, parents will be asked about a current history of night blindness among their young children. These data will be used to describe the distribution of wheat and vitamin A intake by FFW families within the same district that the evaluation trial will take place.

These distributions will be used to estimate post-FFW season intakes of vitamin A in the presence of a wheat fortification program. As with the community trial, all procedures will be fully detailed in a manual of operations, workers trained and standardized, data entered, edited, and analyzed in Dhaka.

I. ACTIVITY PLAN

1. Major Activities to be accomplished during the first year

The schedule of major activities to be accomplished during the first project year is shown in Figure I-1. The schedule is based on authorization of funds by August 1987 and project start-up on September 1, 1987.

2. Baseline Study

Details of the baseline study to asess nutritional impact of wheat fortification are given in Section H.

Figure I-1. FIRST YEAR ACTIVITY PLAN

Activity	1987				1988							
	1 S	2 O	3 N	4 D	5 J	6 F	7 M	8 A	9 M	10 J	11 J	12 A
HKI MANAGEMENT												
Develop detailed Work Plan	___											
Hire Additional Staff	:___	___										
Award Contracts		___	___									
Order equipment, vehicles & supplies												
Organize Coordinating Committees; Meetings		___	___	...	___	...	..._	___	...	...	___	...
Public relations work				___	...	...	...	...	...	...	...	...
Management Reports												
WHEAT FORTIFICATION & DISTRIBUTION												
Receive/Install equipment (Chittagong)								___	___			
Test fortified system (Chittagong & train operators									___	___		
Receive modified bags/tags (Nar'ganj)									___	...	...	...
Fortify wheat (Chittagong)										...	___	___
Bag/distribute fortified wheat (Nar'ganj)											...	___
MONITORING												
Develop wheat prod/dist monitoring procedures				___	___	___	...	...	...	...	...	...
Train wheat prod/dist monitoring staff								___	___	___	___	
Monitor prod/dist fortified wheat									___	___	___	___
Develop Impact Assessment Manual		___	___	___								
Develop & pretest field instruments			___	___	___	___						
Laboratory training						___	___					
Field worker training							___					
Baseline data collection								___	___			
Data entry/editing									___	___	___	___
Cytology analysis									___	___	___	
Baseline data analysis											___	___

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K. PROJECT BUDGET - THREE YEARS

BANGLADESH
FORTIFICATION PROPOSAL BUDGET
APRIL 30, 1987

(IN U.S. DOLLARS)

	YEAR I		YEAR II		YEAR III		TOTAL	
	AID	HKI	AID	HKI	AID	HKI	AID	HKI
Headquarters	-0-		-0-		-0-		-0-	
Field Salary	28,980		31,878		35,190		96,048	
Local Salary	10,600		11,600		12,900		35,100	
Fringe (17.2%)	6,020		6,622		7,310		19,952	
Local Consultants	87,400		108,600		21,000		217,000	
Supplies	6,000	90,000 (Vitamin A)	6,000	90,000 (Vitamin A)	1,000		13,000	180,000 (Vitamin A)
Equipment	33,000	12,000 (Vehicle)	500		500		34,000	12,000 (Vehicle)
Training	-0-		-0-		-0-		-0-	
Transportation	3,500		2,500		3,000		9,000	
Dissemination of Information	-0-		-0-		10,000		10,000	
Reporting/ Evaluation	-0-		31,000		31,500		62,500	
Other Direct	9,000		18,000		19,000		46,000	
Overhead (8.2%)	15,129		17,769		11,595		44,493	
TOTAL	$199,629	$102,000	$234,469	$90,000	$152,995		$587,093	$192,000 (33%)
					TOTAL EXPENSES		$779,093	

K. Budget *US$

	Project Year			
	1	2	3	All
(1) Project Personnel (incl. fringe benefits)				
HKI Country Director (1/3 time)	19,000	21,000	23,000	63,000
HKI Technical Advisor (1/3 time)	16,000	17,500	19,500	53,000
Project Coordinator @$350/mo	4,200	4,600	5,100	13,900
Admin. Secretary @267/mo	3,200	3,500	3,900	10,600
Finance Officer @$267/mo	3,200	3,500	3,900	10,600
Sub Total	45,600	50,100	55,400	151,000
(2) Local Consultants/Contracts				
a. Engineering Services	10,000			10,000
b. Equipment installation	25,000			25,000
c. Impact monitoring	51,400	45,600		97,000
d. Production/Distribution monitoring	-	60,000	20,000	80,000
e. Analytical Services	1,000	3,000	1,000	5,000
Sub-total	87,400	108,600	21,000	217,000
(3) Supplies *				
a. Vitamin A premix	90,000	90,000		180,000
b. Packaging Tags	5,000	5,00	-	10,000
c. Office Supplies	1,000	1,000	1,000	3,000
Sub total	96,000	96,000	1,000	193,000
(4) Equipment				
a. Fortification equipment	25,000			25,000
b. Vehicle*	12,000			12,000
c. Computer	6,00			6,000
d. Office equip./furnishings	2,000	500	500	3,000
Sub total	45,000	500	500	46,000
(5) Transportation				
a. Local and Intl. travel	3,500	2,500	3,000	9,000
Sub-total:	3,500	2,500	3,000	9,000

*HKI contribution

(6) Reporting and evaluation				
a. Consultants		30,000	30,000	60,000
b. Printing of reports		1,000	1,500	2,500
c. Dissemination of Information			10,000	10,000
Sub total		31,000	41,500	72,500
(7) Other Direct Costs				
a. Silo costs for fortification		9,000	9,000	18,000
b. Office rental	2,000	2,000	2,000	6,000
c. Telephone/telex postage/derlivery	2,000	2,500	2,500	7,000
d. Seminars/Conferences/ Meetings	1,000	500	1,500	3,000
e. Materials production/ reproduction	1,500	1,500	1,500	4,500
f. Outside business services	2,500	2,500	2,500	7,500
Sub total	9,000	18,000	19,000	46,000
TOTAL DIRECT COSTS	286,000	306,700	141,400	$734,600
		Overhead @ 8.2% (A.I.D. Portion)		44,493
		TOTAL US$		779,093

EXPLANATIONS OF BUDGET ITEMS

2a. Engineering services: Design of fortification installation at Chittagong and training of plant operators.

2b. Equipment installation: Labor and local materials to install feeder and mixer at Chittagong silo.

2c. Impact monitoring: Community intervention trial to measure the impact of fortification on 1-5 year old vitamin A status; Assessment of wheat consumption by VGF/FFW families.

2d. Production/Distribution Monitoring: Contract to establish monitoring and reporting procedures, institute records and train personnel, overses production and distribution of fortified wheat, and provide reports to HKI.

2e. Analytical services: Contract to analyze vitamin A content of wheat in samples from silo, depots, and recipients.

3a. Vitamin A Premix: CIF costs of premix @ US$ 0.30 per lb. (Premix of wheat coated with 1.0 million IU vitamin A per lb.)

3b. Packaging tags: Cardboard tags indicating code for production date and batch of fortified wheat.

4a. Fortification equipment: Premix feeder, 1/2-tons per hour and continuous mixer, 100-200 ton per hours.

4b. Vehicle: Longbed van for impact evaluation field workers.

4c. Computer: Mini computer, printer, and accessories to tabulate and analyze data from monitoring activities.

6a. Consultants: International experts to participate in project evaluations (3 each).

7a. Other: Cost for additional personnel, power, and use of GOB Chittagong silo.